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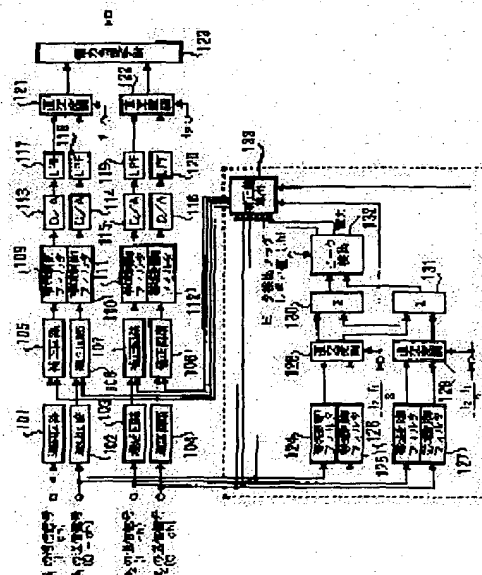
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## (54) RADIO COMMUNICATION EQUIPMENT

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To unnecessitate an amplifier which attenuates peak power before a signal output and prevents distortion from occurring even in case of a large peak power input by correcting peak power before synthesis when detected peak power exceeds a prescribed value.

**SOLUTION:** Band limiting filters 124 to 127 perform band limitation of a transmission base band signal. Orthogonal modulators 128 and 129 orthogonally modulate processing outputs of the filters 124 to 127. A peak power detection circuit 132 detects such peak power as exceeds threshold in results that are subjected to addition processing of orthogonal modulation in adders 130 and 131. If it exceeds the threshold, a target value at which correction is performed is calculated and is communicated to a correction coefficient calculation circuit 133 at the same time as the state by a peak power detection flag. Correction is performed by amplifying inputs of band limiting filters 109 to 112 to correction coefficient times by a correction coefficient calculated by the circuit 133.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The radio communication equipment characterized by providing a synthetic means to compound an amendment peak-power amendment means and the sending signal of each carrier frequency for a peak power before power composition when the detected peak power exceeds a predetermined value, a peak-power detection means to detect each peak power based on the sending signal of two or more carrier frequencies, and.

[Claim 2] The radio communication equipment according to claim 1 characterized by providing the filter which performs filtering processing to the sending signal after peak-power amendment.

[Claim 3] A peak-power detection means is a radio communication equipment according to claim 1 or 2 characterized by computing a peak power by holding a carrier frequency interval in low frequency, and performing quadrature modulation and addition from a carrier frequency.

[Claim 4] A peak-power detection means is a radio communication equipment according to claim 1 to 3 to which frequency is characterized by having a quadrature modulation means to perform the zero IF modulation centering on 0Hz.

[Claim 5] The radio communication equipment characterized by providing the following. The filter which carries out filtering processing to the sending signal of two or more carrier frequencies, respectively, a synthetic means to compound the sending signal after filtering, and the transmitting system equipped with the amendment amendment means for the peak power before filtering processing. The peak-power amendment system which detected each peak power based on the sending signal of two or more aforementioned carrier frequencies, and was equipped with a peak-power correction value calculation means to compute correction value based on the detected peak power, and to send this correction value to the aforementioned amendment means.

[Claim 6] A transmitting system is a radio communication equipment according to claim 5 characterized by having a quadrature modulation means to perform quadrature modulation to the sending signal of an analog.

[Claim 7] A transmitting system is a radio communication equipment according to claim 5 characterized by having a quadrature modulation means to perform quadrature modulation to a digital sending signal.

[Claim 8] A peak-power amendment system is a radio communication equipment according to claim 5 to 7 characterized by having a filter with tap length shorter than the aforementioned filter.

[Claim 9] Base station equipment characterized by having a radio communication equipment according to claim 1 to 8.

[Claim 10] Mobile station equipment characterized by having a radio communication equipment according to claim 1 to 8.

[Claim 11] The transmitted peak-power curtailment method characterized by providing the process which detects each peak power based on the sending signal of two or more carrier frequencies, the process which computes correction value when this peak power exceeds a threshold, and the process which performs filtering processing to the sending signal of the amplitude amended with the amendment process in the amplitude of a sending signal according to this correction value.

[Claim 12] The transmitted peak-power curtailment method according to claim 11 characterized by adjusting a threshold according to a modulation technique.

[Claim 13] The transmitted peak-power curtailment method according to claim 11 characterized by adjusting a threshold according to the band limit method.

[Claim 14] The transmitted peak-power curtailment method according to claim 11 which a communication mode is CDMA and is characterized by adjusting a threshold according to a code multiplex number.

[Claim 15] The transmitted peak-power curtailment method according to claim 11 to 14 characterized by amending to the sending signal from which the tap coefficient of a filter serves as largest value.

[Claim 16] The transmitted peak-power curtailment method according to claim 11 to 14 characterized by amending to the amplitude of the sending signal from which the result which carried out the multiplication of the tap coefficient of a filter to the sum of the product between the in-phase component which carried out quadrature modulation of the sending signal, and the in-phase component which carried out quadrature modulation of the filter output, and the product between the quadrature component which carried out quadrature modulation of the sending signal, and the quadrature component which carried out quadrature modulation of the filter output serves as the maximum.

[Claim 17] The radio method characterized by providing the following. The process which cuts down the peak of transmitted power by the transmitted peak-power curtailment method according to claim 11 to 16, and obtains a band limited signal. The process which performs quadrature modulation to a zero IF signal at intervals of each carrier frequency to this band limited signal. The process which adds the in-phase component and quadrature component of a sending signal after quadrature modulation, respectively, and is changed into an analog signal. The process which carries out quadrature modulation of the sending signal of each carrier frequency after conversion.

[Claim 18] The radio method characterized by providing each process which performs quadrature modulation at intervals of a carrier frequency, and the process which adds the sending signal after a modulation, respectively and is changed into an analog signal to the process which cuts down the peak of transmitted power by the transmitted peak-power curtailment method according to claim 11 to 16, and obtains a band limited signal, and this band limited signal.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the radio communication equipment which transmits by two or more carrier frequencies.

[0002]

[Description of the Prior Art] The conventional communication device, especially a radio communication equipment are explained using JP,8-274734,A. Drawing 10 is the block diagram showing the composition of the conventional radio communication equipment. In the radio communication equipment which has this composition, frequency conversion of the input modulating signal inputted from input terminals 111-11n is carried out to the signal of a frequency band which is mutually different with 121-12n of frequency-conversion meanses, respectively through variable attenuators 211-21n, signal multiplexing is supplied and carried out and these conversion outputs are outputted to the power composition means 16. The multiplexing output part branches and envelope power level is detected with the level detection means 23. Control means 24 are controlled to Attenuators 211-21n to decrease the time about  $1/\Delta f_0$  (second) (for  $f_0$  to be the bandwidth frequency of a multiplexed signal), and the mean power of modulating-signal power  $k/n$  or less twice, when the disregard-level  $L$  exceeds mean power  $k$  times the level  $L_s$  ( $k$  is about 4 to 5 times) of a multiplexed signal.

[0003]

[Problem(s) to be Solved by the Invention] However, there are the following technical problems of two points in a Prior art. First, in a Prior art, in order to determine the magnitude of attenuation based on the power compounded with the power composition means, the technical problem that it will be outputted produces a sending signal from a power composition means between processings of a level detection means, control means, and attenuating means. For this reason, it is necessary to make it composition which a strain does not generate about latter amplifier at the time of a big peak-power input, either. Generally, a size and the calorific value of such amplifier are large, and it is expensive.

[0004] Moreover, by the Prior art, the FSK signal is considered to the sending signal. In the FSK modulating signal, symbol time serves as single frequency. Symbol frequency is usually several kHz - hundreds of kHz. This is very long time to  $1/\Delta f_0$  of time which has been indicated in a specification and to attenuate. Therefore, even if the reaction rate for attenuation is somewhat slow, it fully functions.

[0005] However, in a PSK modulation technique or a QAM modulation technique, an amplitude and a phase change during symbol time. The speed of this change is almost equivalent to the speed of change of a power addition result. Therefore, when the reaction rate for attenuation is slow, suppression of a peak power will not meet the deadline, but it will decrease in the time which has not exceeded the size which the power addition result assumes.

[0006] this invention is made in view of this point, a peak power can be attenuated before a signal output, and it aims at offering the radio communication equipment which can make unnecessary the amplifier of composition so that a strain may not occur at the time of a big peak-power input, either.

[0007]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, this invention provided the following meanses.

[0008] Invention about a radio communication equipment according to claim 1 takes the composition possessing a peak-power detection means to detect each peak power based on the sending signal of two or more carrier frequencies, and a synthetic means to compound an amendment peak-power amendment means and the sending signal of each carrier frequency for a peak power before power composition when the detected peak power exceeds a predetermined value.

[0009] the time of exceeding a predetermined value according to this composition -- a peak power -- before power

composition -- an amendment -- since things are made, a peak power can be attenuated before a signal output and the amplifier of composition so that a strain may not occur at the time of a big peak-power input, either can be made unnecessary

[0010] In a radio communication equipment according to claim 1, it is desirable to provide the filter which performs filtering processing to the sending signal after peak-power amendment like invention according to claim 2.

[0011] Invention according to claim 3 takes the composition in which a peak-power detection means computes a peak power by holding a carrier frequency interval in low frequency, and performing quadrature modulation and addition from a carrier frequency in a radio communication equipment according to claim 1 or 2.

[0012] According to this composition, the peak power of the added signal which carried out quadrature modulation in the state of the several MHz digital signal is detectable.

[0013] The composition which has a quadrature modulation means by which invention according to claim 4 performs a centering on 0Hz zero [ means / peak-power detection / frequency ] IF modulation in a radio communication equipment according to claim 1 to 3 is taken.

[0014] According to this composition, the sampling frequency of a digital circuit can be made the smallest. Moreover, since IF frequency is outputted, the number of a D/A converter can be cut down to one piece, and an analog quadrature modulation circuit can be cut down.

[0015] Invention about a radio communication equipment according to claim 5 The filter which carries out filtering processing to the sending signal of two or more carrier frequencies, respectively, a synthetic means to compound the sending signal after filtering, and the transmitting system equipped with the amendment amendment means for the peak power before filtering processing, Each peak power is detected based on the sending signal of two or more aforementioned carrier frequencies, correction value is computed based on the detected peak power, and the composition possessing the peak-power amendment system equipped with a peak-power correction value calculation means to send this correction value to the aforementioned amendment means is taken.

[0016] the time of exceeding a predetermined value according to this composition -- a peak power -- before power composition -- an amendment -- since things are made, a peak power can be attenuated before a signal output and the amplifier of composition so that a strain may not occur at the time of a big peak-power input, either can be made unnecessary

[0017] In a radio communication equipment according to claim 5, the composition that a transmitting system has a quadrature modulation means to perform quadrature modulation to the sending signal of an analog may be used like invention according to claim 6, and the composition of having a quadrature modulation means by which a transmitting system performs quadrature modulation to a digital sending signal, like invention according to claim 7 may be used.

[0018] Invention according to claim 8 takes the composition in which a peak-power amendment system has a filter with tap length shorter than the aforementioned filter in a radio communication equipment according to claim 5 to 7.

[0019] According to this composition, the operation scale or circuit scale of a peak-power calculation circuit is reducible.

[0020] Invention about the transmitted peak-power curtailment method according to claim 11 takes the composition possessing the process which detects each peak power based on the sending signal of two or more carrier frequencies, the process which computes correction value when this peak power exceeds a threshold, and the process which performs filtering processing to the sending signal of the amplitude amended with the amendment process in the amplitude of a sending signal according to this correction value.

[0021] According to this composition, a peak power can be reduced, without generating unnecessary frequency out of band. The back off of amplifier can be reduced by reducing a peak power. Therefore, amplifier can be made small.

[0022] In the transmitted peak-power curtailment method according to claim 11, like invention according to claim 12, a threshold may be adjusted according to a modulation technique and a threshold may be adjusted according to the band limit method. Moreover, when a communication mode is CDMA, according to a code multiplex number, you may adjust a threshold like invention according to claim 14.

[0023] The peak power generated between symbol points by these composition when not using a band limit filter in the peak-power method of detection can be presumed correctly.

[0024] A peak power can be reduced by composition according to claim 12, without generating unnecessary frequency out of band. Moreover, the back off of amplifier can be reduced by reducing a peak power. Therefore, amplifier can be made small.

[0025] Moreover, by composition according to claim 14, since it is a thing for 1 carrier frequency and the band of a quadrature modulation machine can be constituted, a quadrature modulation machine can be constituted cheaply.

[0026] Invention according to claim 15 takes the composition which amends to the sending signal from which the tap coefficient of a filter serves as largest value in the transmitted peak-power curtailment method according to claim 11 to

14.

[0027] According to this composition, it is lost that an unnecessary frequency component generates the amplitude of the signal before inputting into a band limit filter by amplitude amendment for an amendment reason. Moreover, the relation of the quadrature modulation for transmission and power addition, and the quadrature modulation for power calculation and power addition can be constituted without the degradation factor by the analog circuit. And a sampling frequency can be made the smallest.

[0028] Invention according to claim 16 takes the composition which amends to the amplitude of the sending signal from which the result which carried out the multiplication of the tap coefficient of a filter to the sum of the product between the in-phase component which carried out quadrature modulation of the sending signal, and the in-phase component which carried out quadrature modulation of the filter output, and the product between the quadrature component which carried out quadrature modulation of the sending signal, and the quadrature component which carried out quadrature modulation of the filter output serves as the maximum in the transmitted peak-power curtailment method according to claim 11 to 14.

[0029] Since this composition amends to the signal which contributes to a peak power greatly, the amount of amendments can be made small and the amount of strains of a sending signal can be made small. Moreover, the relation of the quadrature modulation for transmission and power addition, and the quadrature modulation for power calculation and power addition can be constituted without the degradation factor by the analog circuit. And a D/A converter can be cut down to one piece and an analog quadrature modulation circuit can be cut down.

[0030] Invention about the radio method according to claim 17 The process which cuts down the peak of transmitted power by the transmitted peak-power curtailment method according to claim 11 to 16, and obtains a band limited signal, The process which performs quadrature modulation to a zero IF signal at intervals of each carrier frequency to this band limited signal, The composition possessing the process which adds the in-phase component and quadrature component of a sending signal after quadrature modulation, respectively, and is changed into an analog signal, and the process which carries out quadrature modulation of the sending signal of each carrier frequency after conversion is taken.

[0031] According to this composition, the relation of the quadrature modulation for transmission and power addition, and the quadrature modulation for power calculation and power addition can be constituted without the degradation factor by the analog circuit. Moreover, a sampling frequency can be made the smallest.

[0032] Invention about the radio method according to claim 18 takes the composition which possesses each process which performs quadrature modulation at intervals of a carrier frequency, and the process which adds the sending signal after a modulation, respectively and is changed into an analog signal to the process which cuts down the peak of transmitted power by the transmitted peak-power curtailment method according to claim 11 to 16, and obtains a band limited signal, and this band limited signal.

[0033] According to this composition, the relation of the quadrature modulation for transmission and power addition, and the quadrature modulation for power calculation and power addition can be constituted without the degradation factor by the analog circuit. Moreover, a D/A converter can be cut down to one piece and an analog quadrature modulation circuit can be cut down.

[0034] this invention offers base station equipment equipped with a radio communication equipment according to claim 1 to 8 like invention according to claim 9, and offers mobile station equipment equipped with a radio communication equipment according to claim 1 to 8 like invention according to claim 10.

[0035]

[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is explained in detail with reference to an accompanying drawing.

[0036] (Gestalt 1 of operation) Drawing 1 is the block diagram showing the composition of the radio communication equipment concerning the gestalt 1 of operation of this invention. The peak-power curtailment method in a multi-carrier frequency amplification method is used for this radio communication equipment.

[0037] The baseband modulating signal which transmits by the carrier frequency  $f_1$  in delay circuits 101 and 102 is delayed. Similarly, the baseband modulating signal which transmits by the carrier frequency  $f_2$  in delay circuits 103 and 104 is delayed. This time delay is set up so that it may be equivalent to a part for time required for the processing which computes the correction factor for oppressing the peak power of the compound power. In addition, when the calculation time of a correction factor is quick enough, adjustment of the time by the delay circuit becomes unnecessary.

[0038] An amplitude is amended for each delayed signal in the amendment circuits 105-108. This amendment processing is explained later. The band limit filters 109-112 perform band limit processing for the signal which amended an amplitude. The signal band-limited with the band limit filters 109-112 is changed into an analog signal by

D/A converters 113-116. Subsequently, the clench frequency component of the signal changed into the analog signal is removed by LPF 117-120.

[0039] Frequency conversion of the baseband signaling which transmits by the carrier frequency  $f_1$  is carried out to a carrier frequency  $f_1$  with the quadrature modulation vessel 121. Similarly, frequency conversion of the baseband signaling which transmits by the carrier frequency  $f_2$  is carried out to a carrier frequency  $f_2$  with the quadrature modulation vessel 122. Then, the signal of a carrier frequency  $f_1$  and the signal of a carrier frequency  $f_2$  are compounded with the power composition means 123. For example, in using the compound result for a radio communication equipment, it amplifies with amplifier and transmits from an antenna. In using the compound result for wire communication equipment, it amplifies with amplifier and transmits through a cable. Frequency conversion of the compound result may be carried out to a still higher carrier frequency.

[0040] When the difference of the mean power of power and the peak power of a result which carried out power composition is large, the latus amplifier of a dynamic range is needed to mean power. Therefore, it is necessary to oppress a peak power.

[0041] Hereafter, suppression of a peak power is explained. The method of detection of a peak power is explained [ 1st ]. The band limit filters 124-127 band-limit transmitting baseband signaling. When performing peak-level detection strictly, the same thing as the band limit filters 109-112 is used for this filter. However, you may transpose to the filter with which the frequency characteristic was almost equivalent and shortened tap length in order to cut down the circuit scale in the case of carrying out by the purpose or hardware processing which cuts down the amount of operations in the case of performing a band limit filter by software processing.

[0042] Quadrature modulation of the band limit filtering output is carried out with the quadrature modulation vessels 128 and 129. Although this quadrature modulation machine can realize either an analog circuit or a digital circuit, since it is better to perform correction-factor detection processing by digital processing, it is realized by the digital circuit. Drawing 1 shows the case where it realizes by the digital circuit. When realizing by the analog circuit, a D/A converter and LPF are needed.

[0043] When performing quadrature modulation by digital signal processing, quadrature modulation which set center frequency to 0Hz about the baseband modulating signal is performed. For example, when transmitting by the carrier frequency  $f_1$  and the carrier frequency  $f_2$ , quadrature modulation of the signal transmitted by the carrier frequency  $f_1$  is carried out by  $-(f_2-f_1)/2$ , and quadrature modulation of the signal transmitted by the carrier frequency  $f_2$  is carried out by  $+(f_2-f_1)/2$ .

[0044] And I-ch of the signal which carried out quadrature modulation of the baseband modulating signal of a carrier frequency  $f_2$  to I-ch of the signal which carried out quadrature modulation of the baseband modulating signal of a carrier frequency  $f_1$  is added with an adder 130, and Q-ch of the signal which carried out quadrature modulation of the baseband modulating signal of a carrier frequency  $f_2$  to Q-ch of the signal which carried out quadrature modulation of the baseband modulating signal of a carrier frequency  $f_1$  is added with an adder 131. Operation on the frequency shaft of this quadrature modulation processing is shown in drawing 2.

[0045] In addition, in the gestalt of this operation, since quadrature modulation can be performed by digital signal processing, it can carry out by the low carrier frequency. It is better to process by Zero IF in peak-power detection, since there is no difference between the signal of Zero IF and the signal in a low carrier frequency.

[0046] Subsequently, a peak power which exceeds a threshold by the peak-power detector 132 to the result which performed quadrature modulation is detected. An example of a peak-power detector is shown in drawing 3. The square of I-ch is computed in the square circuit 301, and the square of Q-ch is computed in the square circuit 302. And each result is added in an adder circuit 303. This is the power of the result adding the signal which carried out quadrature modulation. Furthermore, the power and the threshold which were added in the comparator circuit 304 are compared, and when the added power is larger than a threshold, the state is told to the correction-factor calculation circuit 133 with a peak-power detection flag. The desired value delta which should amend is computed simultaneously and it tells the correction-factor calculation circuit 133. This is computable by lengthening the power detected from the threshold like the following formula 1. However,  $z_2(t)$  is the power of the result which carried out quadrature modulation of the signal of a multi-carrier frequency.

[0047]

[Equation 1]

$$\delta = z^2(t) - \text{th} \quad \text{式 1}$$

The correction-factor calculation method is explained to the 2nd. amendment of a peak power is performed by alpha doubling an amplitude to a band limit filter input Here, the case where an FIR filter realizes a band limit filter is considered. the input signal of the tap number  $n$  -- alpha twice -- each signal will be set to  $\text{alpha}1 I(t)$ ,  $\text{alpha}1 Q(t)$ ,

alphax2I (t), and alphax2Q (t) if carried out. However, x (t) is a baseband modulating signal, the number in front of a suffix shows a carrier frequency number, and the sign after a suffix expresses I-ch or Q-ch.

[0048] the FIR filter output when alpha doubling the signal of the n-th tap becomes like the following formula 2

However, the suffix number was removed and written to this formula. h ( ) is a tap coefficient, Ts is a sampling rate, and y ( ) is a filter output. Naturally at the time of alpha= 1, the filter output is the same as that of the result which does not amend.

[0049]

[Equation 2]

$$\begin{aligned} y'(t) &= \sum_{i=0}^{N-1} [h(i)x(t-iT_s) + (\alpha-1)h(n)x(t-nT_s)] \\ &= y(t) + (\alpha-1)h(n)x(t-nT_s) \end{aligned} \quad \text{式2}$$

If quadrature modulation of this signal is carried out and it is added, it will become like the following formula 3 - a formula 5.

[Equation 3]

$$z'^2(t) = z'^2_I(t) + z'^2_Q(t) \quad \text{式3}$$

[Equation 4]

$$\begin{aligned} z'_I(t) &= \sum_{k=0}^{K-1} [y'_{kI}(t) \cos \omega_k t - y'_{kQ}(t) \sin \omega_k t] \\ &= z_I(t) + (\alpha-1)h(n) \sum_{k=0}^{K-1} [x_{kI}(t-nT_s) \cos \omega_k t - x_{kQ}(t-nT_s) \sin \omega_k t] \\ &= z_I(t) + (\alpha-1)h(n)X_I(n,t) \end{aligned} \quad \text{式4}$$

[Equation 5]

$$\begin{aligned} z'_Q(t) &= \sum_{k=0}^{K-1} [y'_{kI}(t) \sin \omega_k t + y'_{kQ}(t) \cos \omega_k t] \\ &= z_Q(t) + (\alpha-1)h(n) \sum_{k=0}^{K-1} [x_{kI}(t-nT_s) \sin \omega_k t + x_{kQ}(t-nT_s) \cos \omega_k t] \\ &= z_Q(t) + (\alpha-1)h(n)X_Q(n,t) \end{aligned} \quad \text{式5}$$

However, K is the number of carrier frequencies and omegak is the angular velocity of the carrier frequency number k. A formula 3 becomes the value which lengthened the amendment desired value delta from the power z2 before amendment (t). This comes to show in the following formula 6.

[0050]

[Equation 6]

$$\begin{aligned} z'^2(t) &= z^2(t) + h^2(n)(\alpha-1)^2 \{X_I^2(n,t) + X_Q^2(n,t)\} \\ &\quad + 2h(n)(\alpha-1) \{z_I(t)X_I(n,t) + z_Q(t)X_Q(n,t)\} \\ &= th \end{aligned} \quad \text{式6}$$

From the upper formula 6, the formula for computing a correction factor alpha can be derived. The computed result is shown in the following formula 7.

[Equation 7]

$$\alpha = 1 + \frac{\beta(n,t) \left( 1 \pm \sqrt{1 - X^2(n,t) \{z^2(t) - th\} / \beta^2(n,t)} \right)}{h(n)X^2(n,t)} \quad \text{式7}$$

However, beta (n, t) becomes like the following formula 8.

[Equation 8]

$$\beta(n,t) = z_I(t)X_I(n,t) + z_Q(t)X_Q(n,t) \quad \text{式8}$$

If the contents of the square root of a formula 7 are approximated by the expansion into series and a formula 8 is

substituted for this, it will become like the following formula 9.

[Equation 9]

$$\alpha \approx 1 - \frac{z^2(t) - th}{2h(n)\{z_I(t)X_I(n,t) + z_Q(t)X_Q(n,t)\}} \quad \text{式9}$$

This approximation is effective in the range of the following formula 10, as shown in drawing 4.

[Equation 10]

$$-0.5 < -X^2(n,t)\{z^2(t) - th\} / \beta^2(n,t) \quad \text{式10}$$

[0051] Thus, I-ch and Q-ch ( $z_I(n, t)$  and  $z_Q(n, t)$  in a formula) of a result to which the correction factor alpha compounded tap coefficient [ of the tap number  $n$  ]  $h(n)$ , and the multi-carrier frequency signal, And it became clear that it is computable from I-ch and Q-ch ( $X_I(n, t)$  and  $X_Q(n, t)$  in a formula) of the signal which carried out quadrature modulation of the baseband modulating signal of the tap number  $n$ , and added it. the correction factor alpha computed by the formula 7 or the formula 9 -- using -- the signal of the tap number  $n$  -- alpha twice -- an amendment [0052] The selection method of the above-mentioned tap number can consider the following. In the case of a value with the correction factor near zero, since the sending signal of the time will be set to about 0, the direction with the coefficient near 1 as much as possible is good. Considering a formula 9, as for a correction factor, the one where the value of tap coefficient  $h(n)$  in a denominator is larger approaches 1 more. Therefore, the 1st tap number selection method is the method of making it into the center tap from which a tap coefficient serves as largest value. Moreover, considering a formula 9, as for a correction factor, the case where a denominator is the largest approaches 1. Therefore, the 2nd tap number selection method is the method of choosing the tap coefficient to which a denominator is calculated and the value becomes the largest.

[0053] Amendment is explained [ 3rd ]. the correction factor alpha which computed amendment in the correction-factor calculation circuit 133 -- using -- the input signal of Time  $t$  -- alpha twice -- it carries out

[0054] By the above-mentioned processing, power which carried out multi-carrier composition can be made into a value smaller than a threshold. Thereby, a peak power can be attenuated before a signal output and the amplifier of composition so that a strain may not occur at the time of a big peak-power input, either can be made unnecessary.

[0055] In addition, in the radio communication equipment of the form of this operation, it is guaranteed by amending an amplitude to the input of a band limit filter that amendment of an amplitude does not have a bad influence on frequency. For example, it has a bad influence neither about adjacent-channel disclosure power indispensable as a performance of a walkie-talkie, nor spurious power radiation.

[0056] (Form 2 of operation) Drawing 5 is the block diagram showing the composition of the radio communication equipment concerning the form 2 of operation of this invention. In the radio communication equipment shown in drawing 5, the band limit filter of the peak value amendment portion in the radio communication equipment shown in drawing 1 is omitted. Since a multiplier will generally be needed and a circuit scale will become large if a band limit filter is used, in the form 2 of operation, a peak power is computed in the state where it does not band-limit. In addition, in drawing 5, the sign same about the same portion as drawing 1 is attached, and the explanation is omitted.

[0057] The following problems can be considered when detecting the peak power in the state where it does not band-limit. In PSK or a QAM modulation technique, a peak power is generated between a symbol point and a symbol point. For this reason, a peak power more nearly actual than the peak power generally computed at the symbol point becomes large. Therefore, it is necessary to give a margin to threshold  $\delta$  explained with the form 1 of operation so that it can respond also to the peak power generated between symbol points. this margin -- a constant envelope modulation technique, PSK(s), QAM, such as FSK, etc. -- un--- a law -- it is necessary to change in an envelope modulation technique

[0058] Operation of the radio communication equipment of the above-mentioned composition is explained using drawing 5. Since it is the same as that of the form 1 of operation, operation which compounds the signal of a carrier frequency  $f_1$  and the signal of a carrier frequency  $f_2$  omits explanation.

[0059] The method of detection of a peak power is explained [ 1st ]. Quadrature modulation of the baseband modulating signal is carried out with the quadrature modulation vessels 128 and 129. Although this quadrature modulation machine can realize either an analog circuit or a digital circuit, since it is better to perform correction-factor detection processing by digital processing, it is realized by the digital circuit. Drawing 5 shows the case where it realizes by the digital circuit. When realizing by the analog circuit, a D/A converter and LPF are needed.

[0060] When performing quadrature modulation by digital signal processing, quadrature modulation which set center frequency to 0Hz about the baseband modulating signal is performed. When transmitting by the carrier frequency  $f_1$

and the carrier frequency  $f_2$ , quadrature modulation of the signal transmitted by the carrier frequency  $f_1$  is carried out by  $-(f_2-f_1)/2$ , and quadrature modulation of the signal transmitted by the carrier frequency  $f_2$  is carried out by  $+(f_2-f_1)/2$ . And I-ch of the signal which carried out quadrature modulation of the baseband modulating signal of a carrier frequency  $f_2$  to I-ch of the signal which carried out quadrature modulation of the baseband modulating signal of a carrier frequency  $f_1$  is added with an adder 130, and Q-ch of the signal which carried out quadrature modulation of the baseband modulating signal of a carrier frequency  $f_2$  to Q-ch of the signal which carried out quadrature modulation of the baseband modulating signal of a carrier frequency  $f_1$  is added with an adder 131. The frequency shaft top of this quadrature modulation processing is as being shown in drawing 2.

[0061] In addition, it is better to process by Zero IF, since there is no difference between the signal of Zero IF and the signal in a low carrier frequency in peak-power detection, although quadrature modulation can be performed by the low carrier frequency.

[0062] Next, a peak power which exceeds a threshold by the peak-power detector 132 to the result which performed quadrature modulation is detected. The peak-power detector is the same as that of what is used in the form 1 of operation.

[0063] Furthermore, the power and the threshold which were added in the comparator circuit 304 are compared, and when the added power is larger than a threshold, the state is told to the correction-factor calculation circuit 133 with a peak-power detection flag. The desired value delta which should amend is computed simultaneously and it tells the correction-factor calculation circuit 133. This is computable by lengthening the power detected from the threshold. However,  $z_2(t)$  is the power of the result which carried out quadrature modulation of the signal of a multi-carrier frequency. In addition, since the peak power is not measured to the output using the actually transmitted band limit filter, a hat is attached and it specifies that it is estimate.

[0064]

[Equation 11]

$$\delta = \hat{z}^2(t) - th \quad \text{式 11}$$

[Equation 12]

$$\hat{z}^2(t) = \hat{z}_I^2(t) + \hat{z}_Q^2(t) \quad \text{式 12}$$

[Equation 13]

$$\begin{aligned} \hat{z}_I(t) &= \sum_{k=0}^{K-1} [x_{kI}(t-nT_s) \cos \omega_k t - x_{kQ}(t-nT_s) \sin \omega_k t] \\ &= X_I(n, t) \end{aligned} \quad \text{式 13}$$

[Equation 14]

$$\begin{aligned} \hat{z}_Q(t) &= \sum_{k=0}^{K-1} [x_{kI}(t-nT_s) \sin \omega_k t + x_{kQ}(t-nT_s) \cos \omega_k t] \\ &= X_Q(n, t) \end{aligned} \quad \text{式 14}$$

[0065] As shown in drawing 6, in the case of the peak-power measuring method which excluded interpolation processing and band limit filtering, the power A which happens by the state transition of a symbol point and a symbol point cannot be measured, but it can measure the power B in a symbol point, as mentioned above. The ratio of this power A (PA) and power B (PB) changes with the properties of a modulation technique or a band limit filter. Moreover, even when carrying out multiplex [ of the diffusion sign ] like a CDMA communication mode and transmitting, the ratios of Power A and Power B differ. Therefore, the ratio of this power A and Power B is beforehand measured by the simulation etc., and a threshold (th) is amended. The amendment method becomes like the following formula 15.

[0066]

[Equation 15]

$$th' = \frac{P_A}{P_B} th \quad \text{式 15}$$

The correction-factor calculation method is explained to the 2nd. The amendment method is computable like the form 1 of operation. To  $z_I(t)$  of a formula 6, and  $z_Q(t)$ , if a formula 13 and a formula 14 are substituted, it will become like

the following formula 16.

[0067]

[Equation 16]

$$\begin{aligned} z^2(t) &= \hat{z}^2(t) + h^2(n)(\alpha - 1)^2 \{X_I^2(n, t) + X_Q^2(n, t)\} \\ &\quad + 2h(n)(\alpha - 1) \{ \hat{z}_I(t) X_I(n, t) + \hat{z}_Q(t) X_Q(n, t) \} \\ &= X^2(t) + h^2(n)(\alpha - 1)^2 X^2(n, t) + 2h(n)(\alpha - 1) X^2(n, t) \\ &= th \end{aligned}$$

式16

Moreover, if a correction factor alpha is computed, it will become like the following formula 17.

[Equation 17]

$$\alpha = 1 - \frac{1 \pm \sqrt{th / X^2(n, t)}}{h(n)} \quad \text{式17}$$

[0068] Thus, it became clear that a correction factor alpha is computable from tap coefficient [ of the tap number n ] h(n) and the power (X<sup>2</sup> in a formula (n, t)) of the signal which carried out quadrature modulation of the baseband modulating signal of the tap number n, and added it. the correction factor alpha computed by the formula 17 -- using -- the signal of the tap number n -- alpha twice -- an amendment In addition, the selection method of the above-mentioned tap number is the same as that of the form 1 of operation.

[0069] By the above-mentioned processing, power which carried out multi-carrier composition can be made into a value smaller than a threshold. Thereby, a peak power can be attenuated before a signal output and the amplifier of composition so that a strain may not occur at the time of a big peak-power input, either can be made unnecessary. Furthermore, since in addition to the effect of the form 1 of operation it is a correction value calculation side and a band limit filter is not used, it is possible to make a circuit scale small.

[0070] In addition, in the radio communication equipment of the form of this operation, it is guaranteed by amending an amplitude to the input of a band limit filter that amendment of an amplitude does not have a bad influence on frequency. For example, it has a bad influence neither about adjacent-channel disclosure power indispensable as a performance of a walkie-talkie, nor spurious power radiation.

[0071] (Form 3 of operation) Drawing 7 is the block diagram showing the composition of the radio communication equipment concerning the form 3 of operation of this invention. In the radio communication equipment shown in drawing 7, it has composition which carries out quadrature modulation in the digital state. In addition, in drawing 7, the sign same about the same portion as drawing 1 is attached, and the explanation is omitted.

[0072] The baseband modulating signal which transmits by the carrier frequency f<sub>1</sub> in delay circuits 101 and 102 is delayed. Similarly, the baseband modulating signal which transmits by the carrier frequency f<sub>2</sub> in delay circuits 103 and 104 is delayed. This time delay is set up so that it may be equivalent to a part for time required for the processing which computes the correction factor for oppressing the peak power of the compound power. In addition, when the calculation time of a correction factor is quick enough, adjustment of the time by the delay circuit becomes unnecessary.

[0073] An amplitude is amended for each delayed signal in the amendment circuits 105-108. This amendment processing is explained later. The band limit filters 109-112 perform band limit processing for the signal which amended an amplitude. In the quadrature modulation circuit 701, quadrature modulation of the signal band-limited with the band limit filters 109 and 110 is carried out by carrier frequency - (f<sub>2</sub>-f<sub>1</sub>) / 2. Moreover, in the quadrature modulation circuit 702, quadrature modulation of the signal band-limited with the band limit filters 111 and 112 is carried out by carrier frequency + (f<sub>2</sub>-f<sub>1</sub>) / 2. However, it is referred to as f<sub>2</sub>>f<sub>1</sub>.

[0074] And I-ch of each quadrature modulation result is added with an adder 703, and Q-ch of each quadrature modulation result is added with an adder 704. This is processing which generally creates a zero IF signal. Since the frequency band expressed as a digital signal becomes the smallest when realizing by these zero IF, a sampling frequency can be made the smallest. The expression on a frequency shaft is as being shown in drawing 2.

[0075] Subsequently, a digital signal is changed into an analog signal by D/A converters 705 and 706. The clench frequency component of the signal changed into the analog signal is removed by LPF 707 and 708.

[0076] Furthermore, quadrature modulation of these signals is carried out in the analog quadrature modulation circuit 709, an unnecessary frequency component is removed from the signal by which quadrature modulation was carried out by BPF710, a rise conversion is carried out with a mixer 711 at a carrier frequency, and an unnecessary frequency component is removed by BPF712.

[0077] When using for a radio communication equipment, after amplifying with amplifier the result changed into the carrier frequency, it transmits from an antenna. Moreover, when using for wire communication equipment, the result changed into the carrier frequency is amplified with amplifier, and it transmits through a cable.

[0078] In addition, the method of detection of a peak power is the same as that of the gestalt 1 of operation, and the gestalt 2 of operation. In the method of detection of the peak power of the gestalt 2 of operation, the band limit filters 124-127 become unnecessary. Moreover, the calculation method and the amendment method of a correction factor  $\alpha$  are also the same as that of the gestalt 1 of operation, and the gestalt 2 of operation.

[0079] By the above-mentioned processing, power which carried out multi-carrier composition can be made into a value smaller than a threshold. Thereby, a peak power can be attenuated before a signal output and the amplifier of composition so that a strain may not occur at the time of a big peak-power input, either can be made unnecessary. Moreover, since the power composition method using the quadrature modulation for transmission and the power composition method using the quadrature modulation of a detecting-peak power sake are made the same, namely, are performed in the state of digital one, a peak power can be detected correctly and a peak power can be oppressed based on it.

[0080] In addition, in the radio communication equipment of the gestalt of this operation, it is guaranteed by amending an amplitude to the input of a band limit filter that amendment of an amplitude does not have a bad influence on frequency. For example, it has a bad influence neither about adjacent-channel disclosure power indispensable as a performance of a walkie-talkie, nor spurious power radiation.

[0081] (Gestalt 4 of operation) Drawing 8 is the block diagram showing the composition of the radio communication equipment concerning the gestalt 4 of operation of this invention. In the radio communication equipment shown in drawing 8, it has the composition of not performing zero IF processing. In addition, in drawing 8, the sign same about the same portion as drawing 7 is attached, and the explanation is omitted.

[0082] The baseband modulating signal which transmits by the carrier frequency  $f_1$  in delay circuits 101 and 102 is delayed. Similarly, the baseband modulating signal which transmits by the carrier frequency  $f_2$  in delay circuits 103 and 104 is delayed. This time delay sets up the correction factor for peak suppression of envelope power so that it may be equivalent to a part for time required for calculation processing. In addition, when the calculation time of a correction factor is quick enough, adjustment of the time by the delay circuit becomes unnecessary.

[0083] An amplitude is amended for each delayed signal in the amendment circuits 105-108. This amendment processing is explained later. The band limit filters 109-112 perform band limit processing for the amended signal. In the quadrature modulation circuit 701, quadrature modulation of the signal band-limited with the band limit filters 109 and 110 is carried out by the carrier frequency  $f_1$ . In the quadrature modulation circuit 702, quadrature modulation of the signal band-limited with the band limit filters 111 and 112 is carried out by the carrier frequency  $f_2$ . Furthermore, these signals are added with an adder 801. The expression on a frequency shaft is as being shown in drawing 9.

[0084] Next, a digital signal is changed into an analog signal for an addition result by D/A converter 802, an unnecessary frequency component is removed by BPF710, a rise conversion is carried out with a mixer 711 at a carrier frequency, and an unnecessary frequency component is removed by BPF712.

[0085] When using for a radio communication equipment, after amplifying with amplifier the result changed into the carrier frequency, it transmits from an antenna. Moreover, when using for wire communication equipment, the result changed into the carrier frequency is amplified with amplifier, and it transmits through a cable.

[0086] In addition, the method of detection of a peak power is the same as that of the gestalt 1 of operation, and the gestalt 2 of operation. When computing a peak power by the method of the gestalt 2 operation, the band limit filters 124-127 become unnecessary. Moreover, the calculation method of a correction factor  $\alpha$  and the amendment method are the same as that of the gestalt 1 of operation, and the gestalt 2 of operation.

[0087] Since the power composition method using the quadrature modulation for transmission and the power composition method using the quadrature modulation of a detecting-peak power sake are made the same, namely, the above-mentioned processing performs them in the state of digital one, a peak power can be detected correctly and a peak power can be oppressed based on it. Moreover, since it is a thing for 1 carrier frequency and the band of a quadrature modulation machine can be constituted, a quadrature modulation machine can be constituted cheaply.

[0088] In addition, in the gestalten 1-4 of the above-mentioned implementation, although the case where a carrier frequency is two is explained in order to simplify explanation, in this invention, the number of carrier frequencies is good by arbitrary numbers.

[0089] Moreover, in the gestalten 1-4 of the above-mentioned implementation, a threshold can be adjusted according to a modulation technique and the band limit method. Moreover, when a communication mode is CDMA, a threshold can be adjusted according to a code multiplex number.

[0090] The radio communication equipment of this invention can be carried in base station equipment or mobile station

equipment, and can be used for the radio communications system which performs radio between base station equipment and mobile station equipment.

[0091]

[Effect of the Invention] The radio communication equipment which adopts the peak-power curtailment method under two or more carrier frequency communication mode which starts this invention as explained above can attenuate a peak power before a signal output, and can make unnecessary the amplifier of composition so that a strain may not occur at the time of a big peak-power input, either.

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[Translation done.]

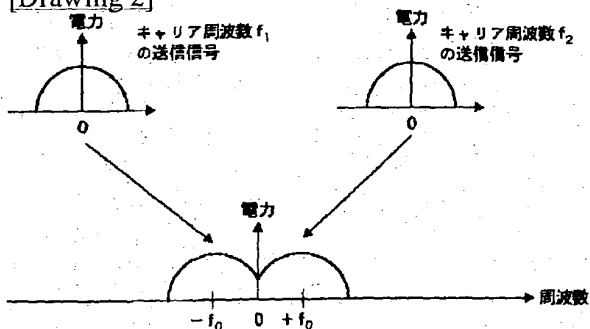
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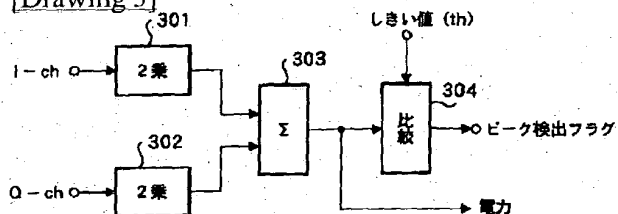
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## DRAWINGS

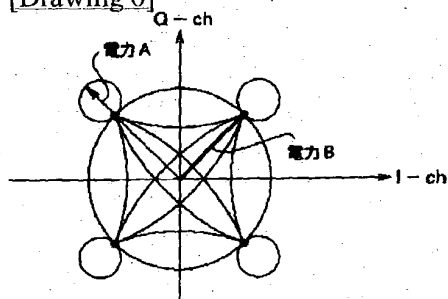
[Drawing 2]



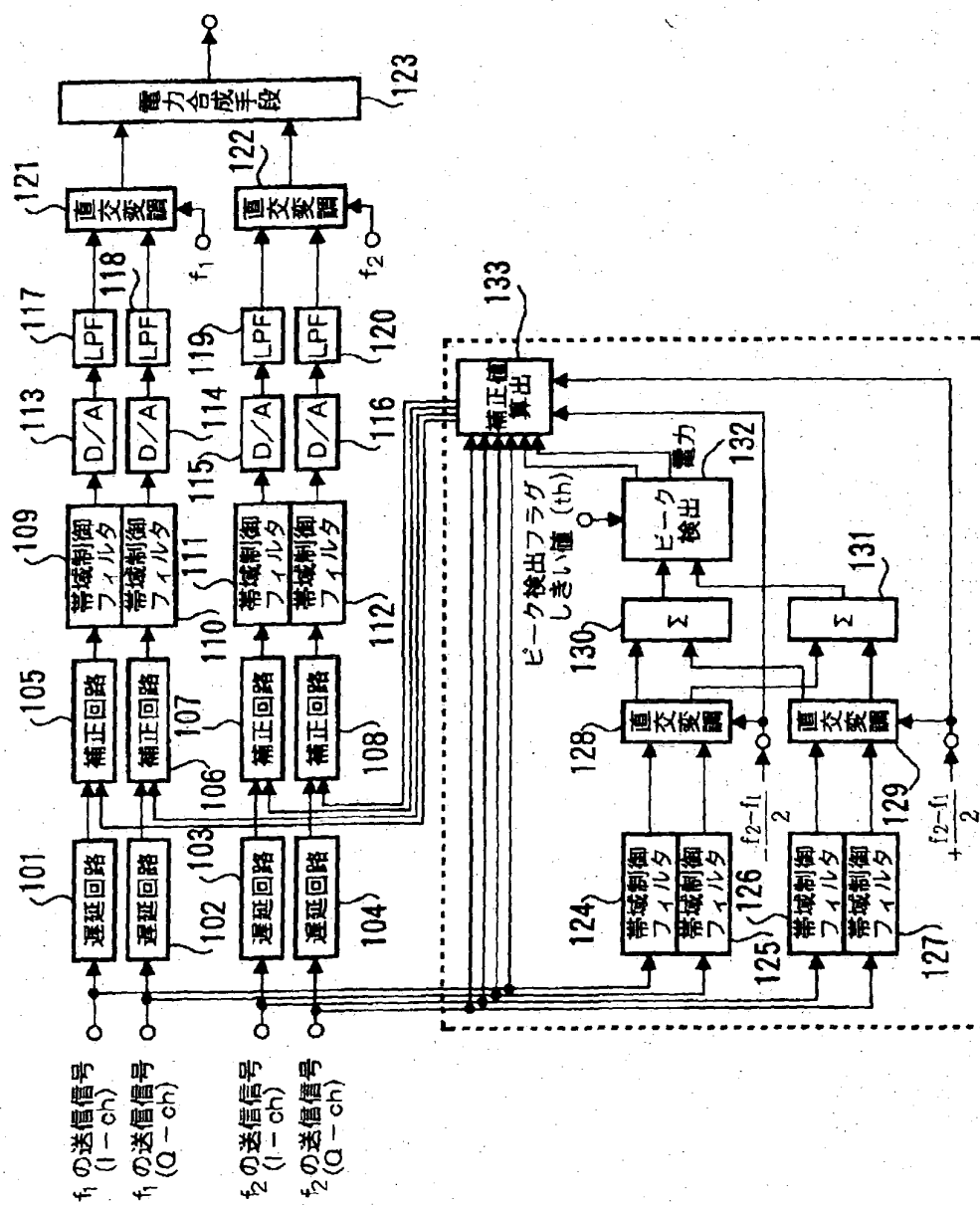
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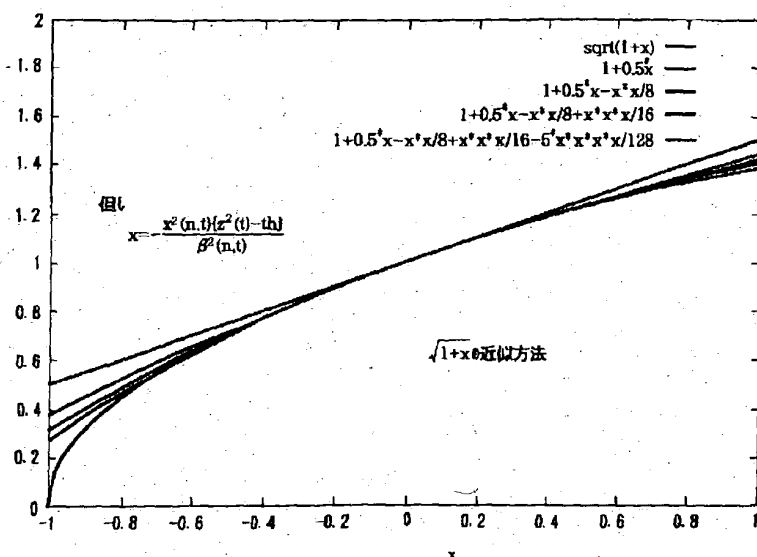
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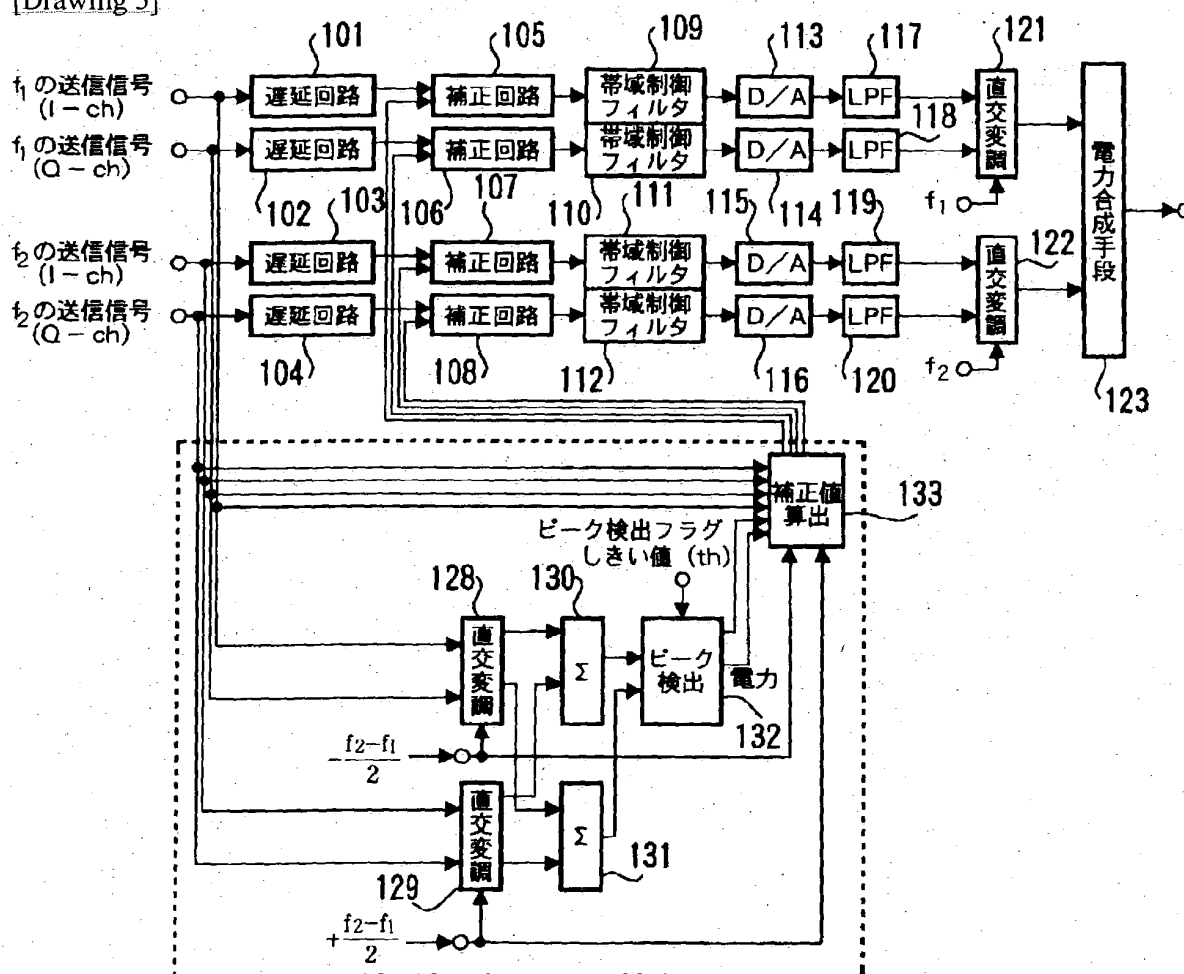
[Drawing 1]



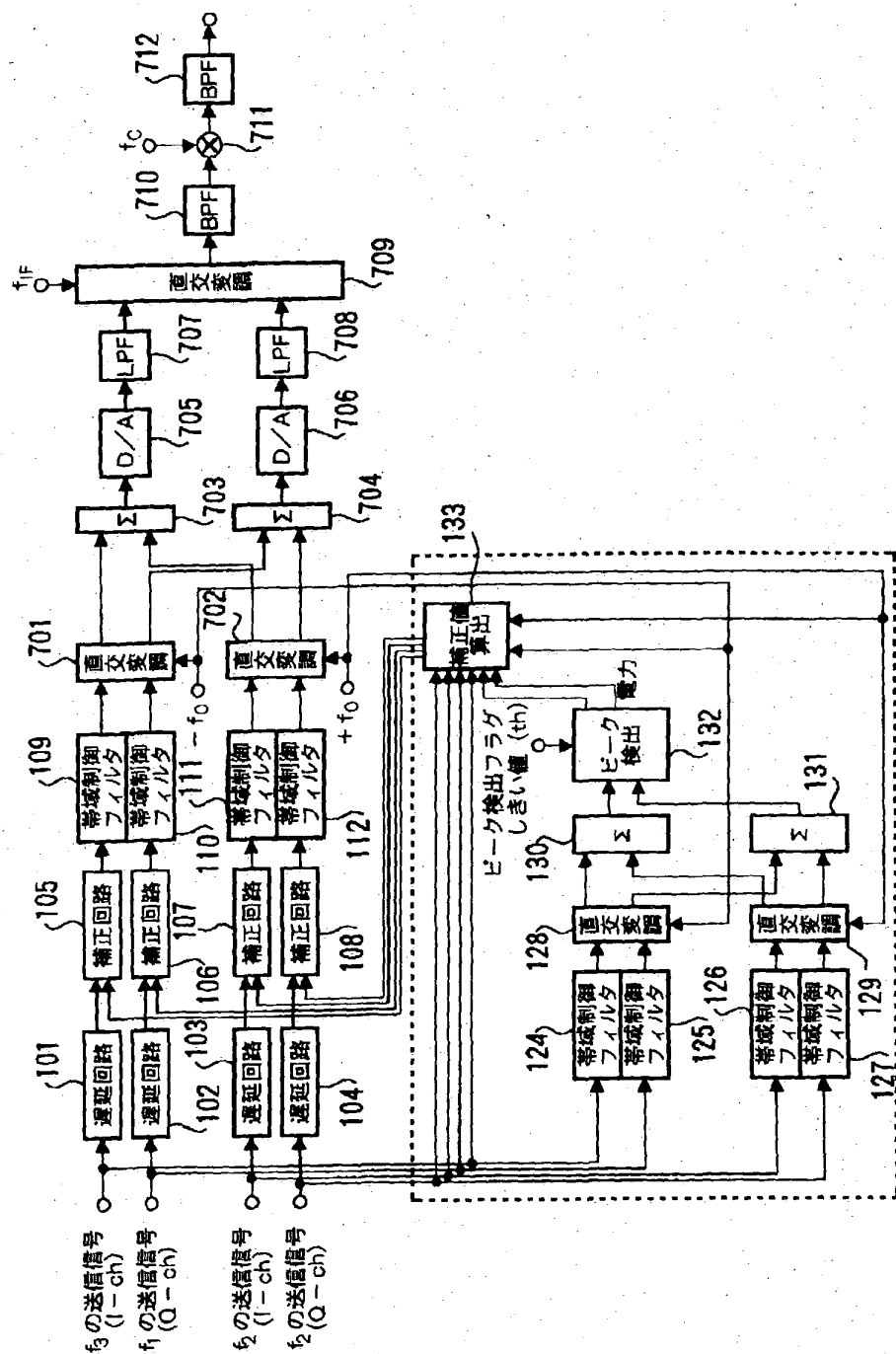
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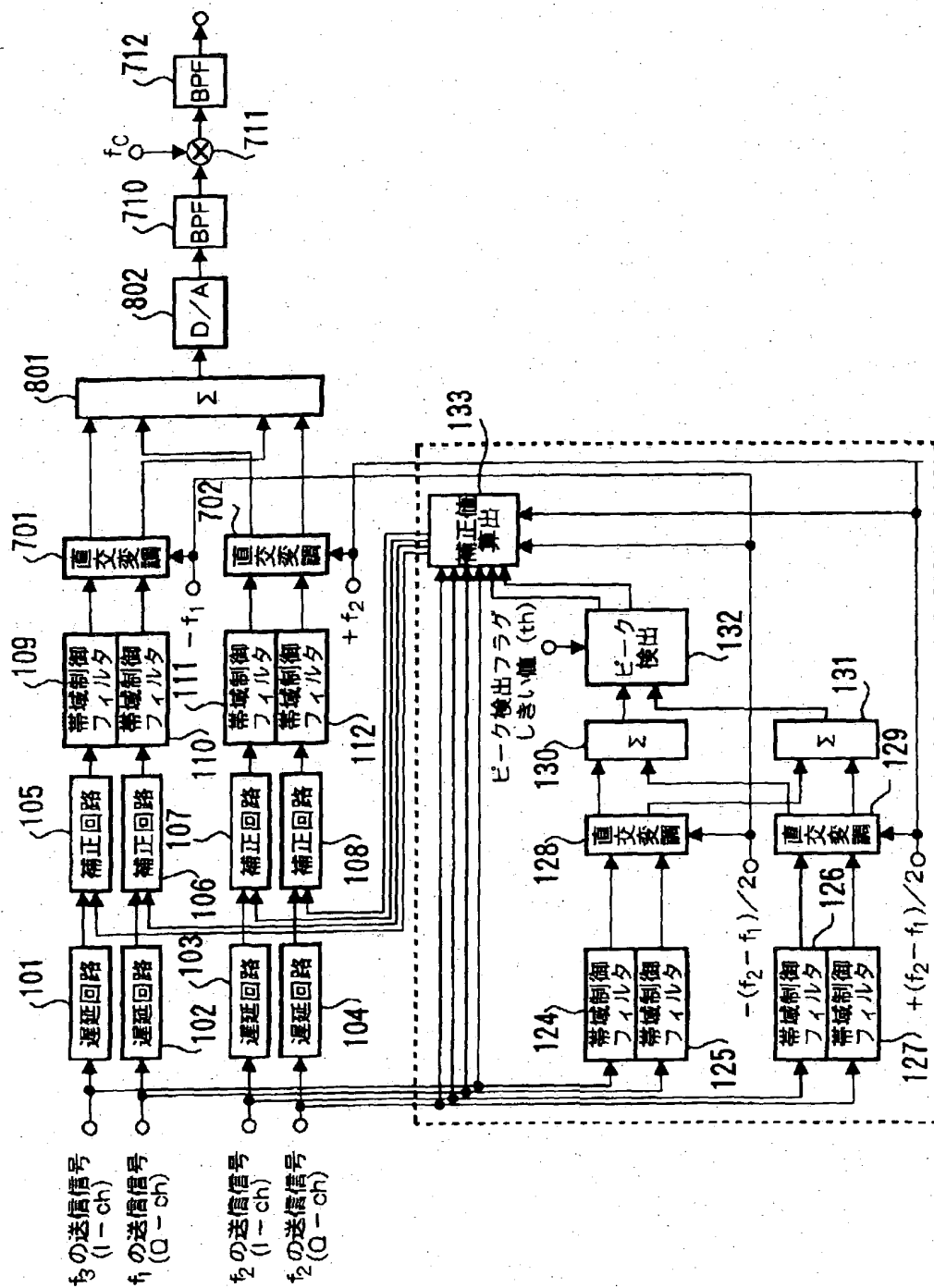
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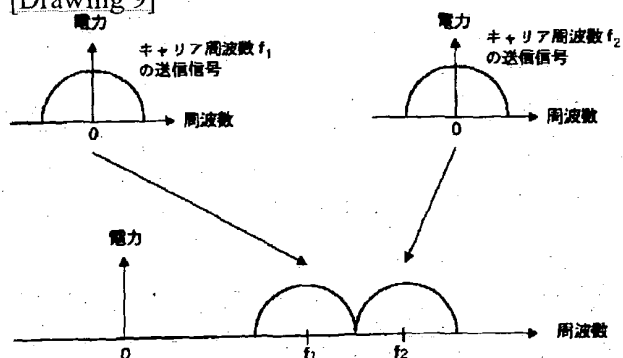
[Drawing 7]



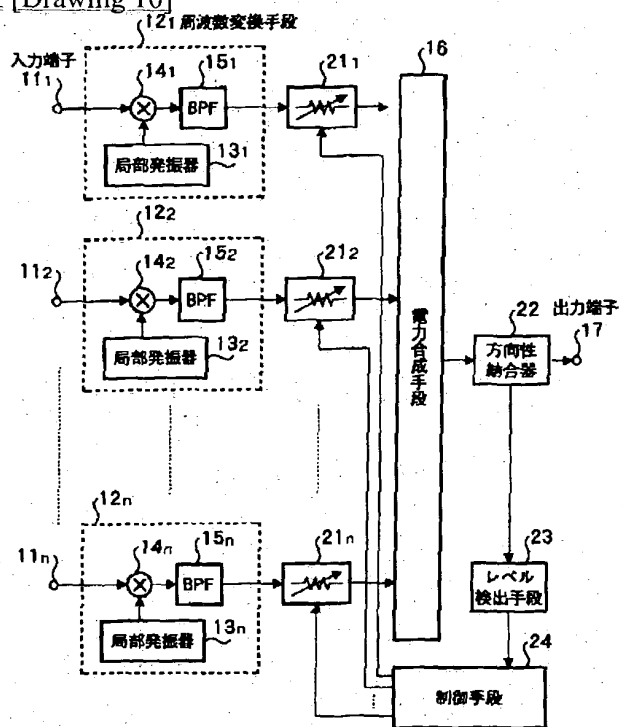
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]

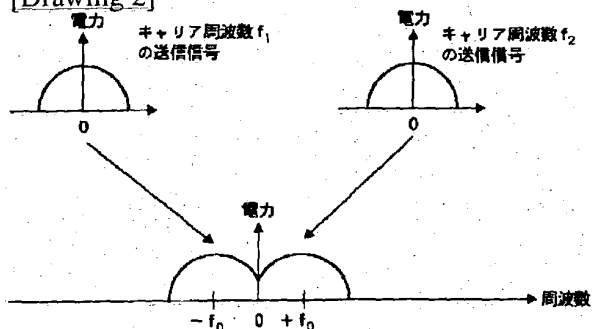
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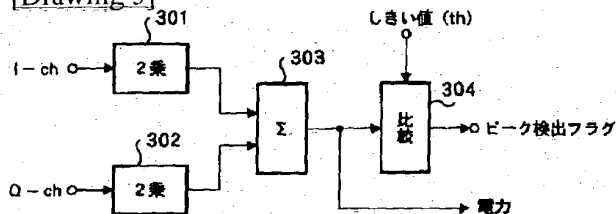
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## DRAWINGS

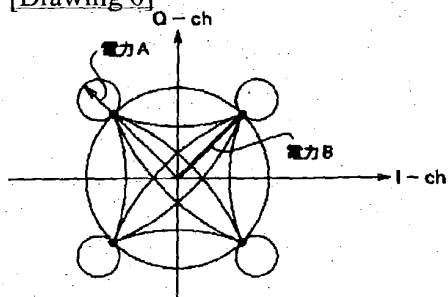
[Drawing 2]



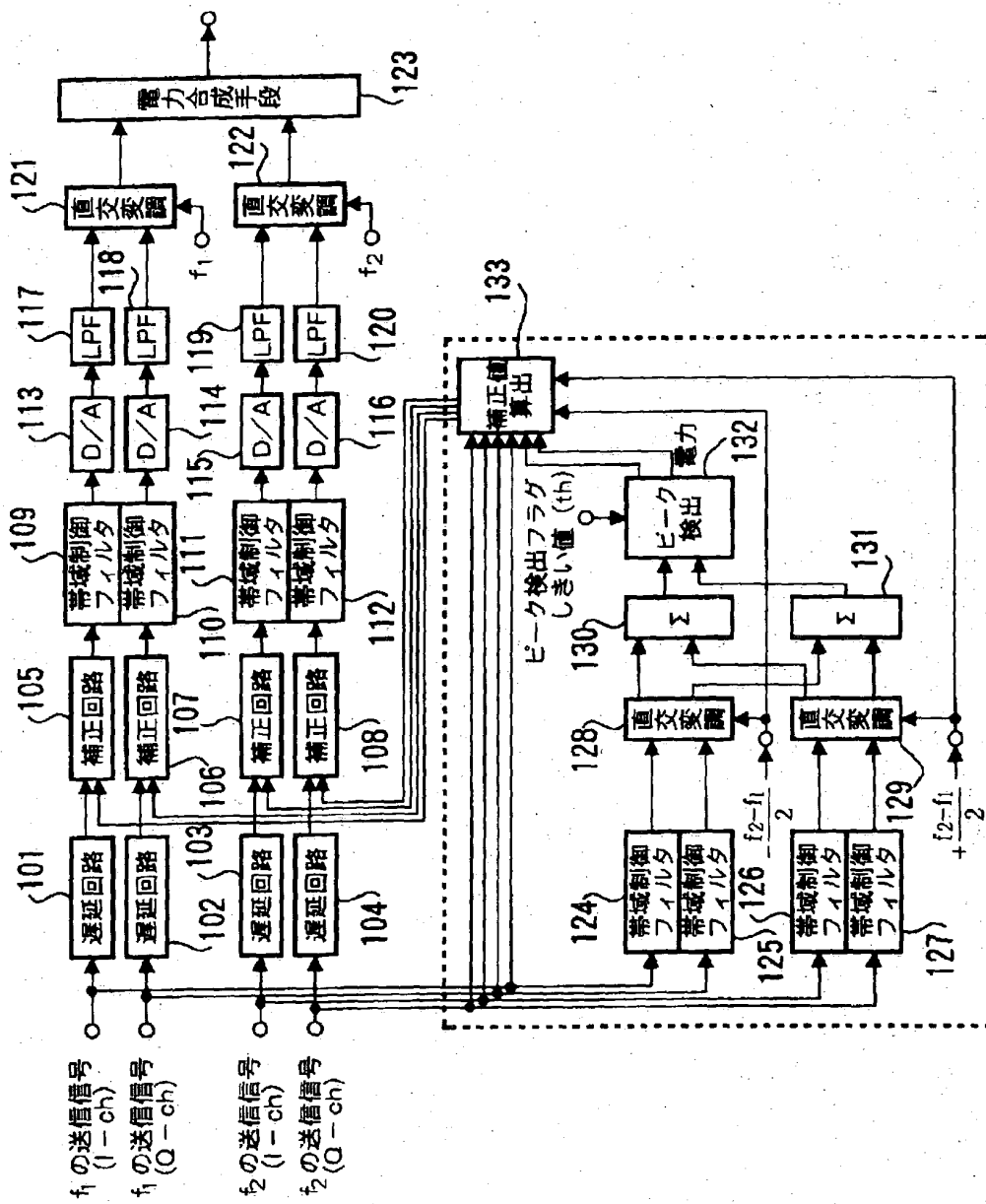
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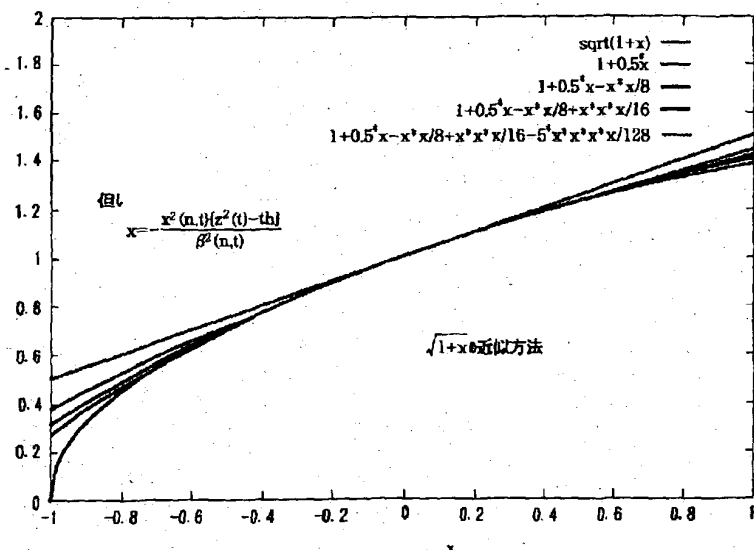
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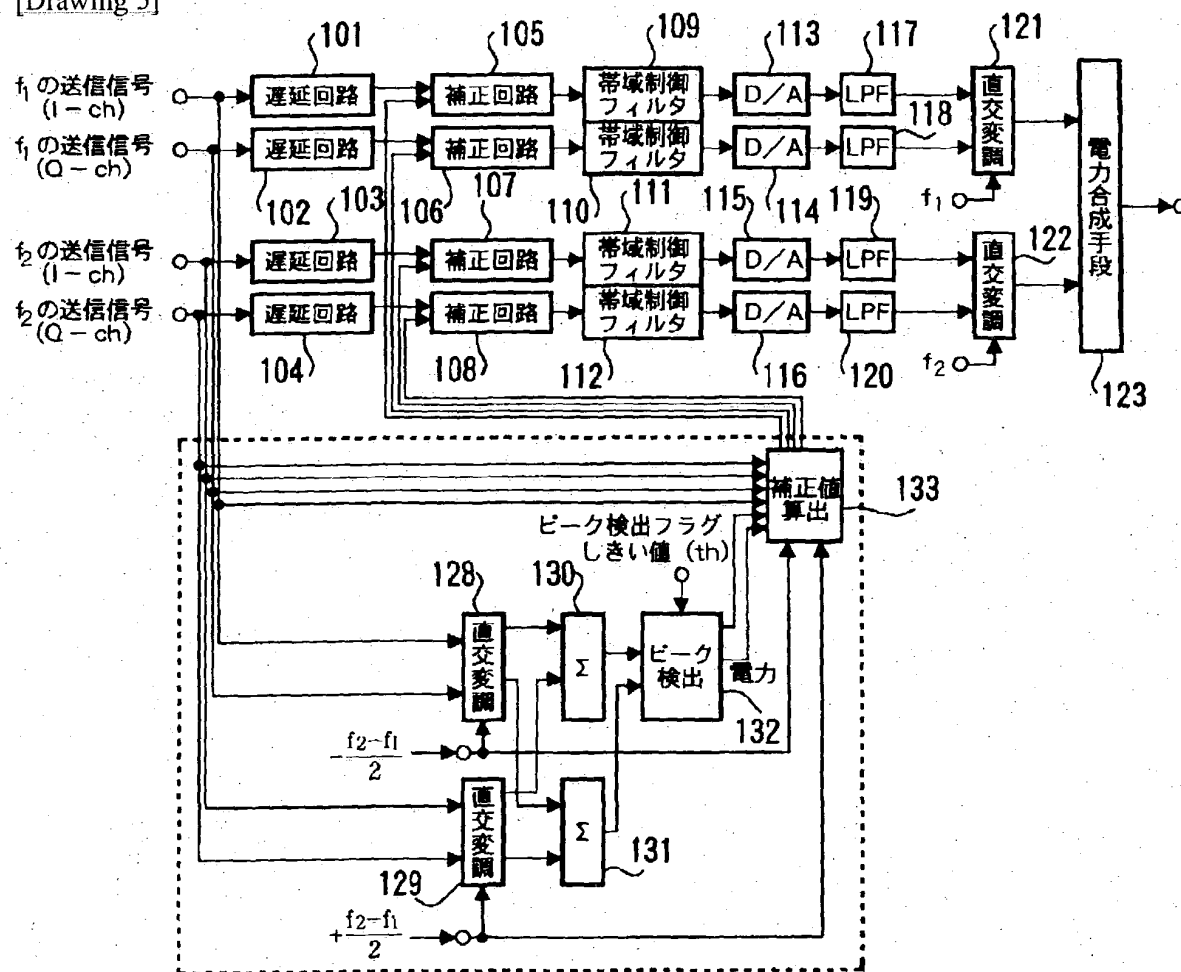
[Drawing 1]



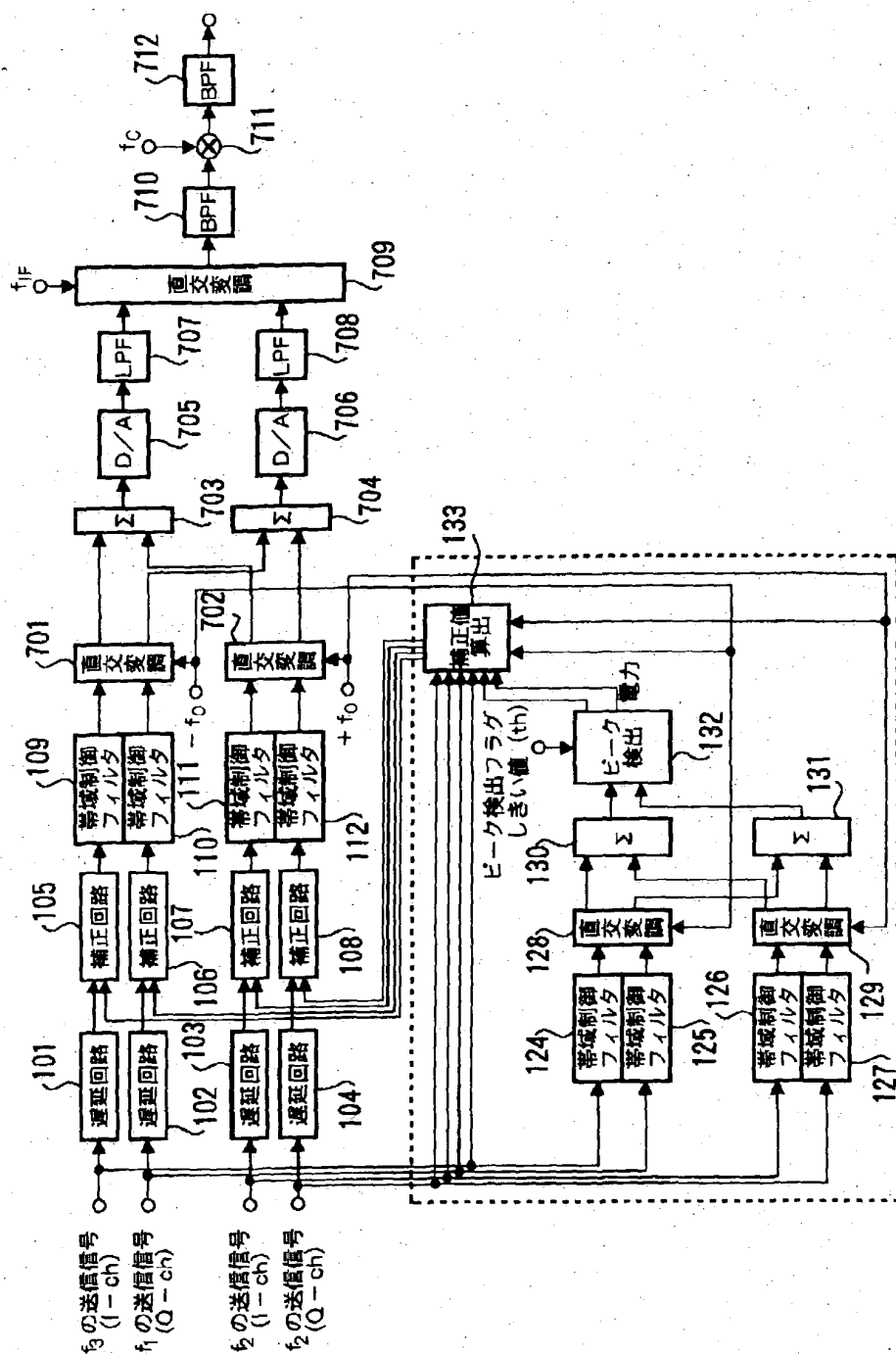
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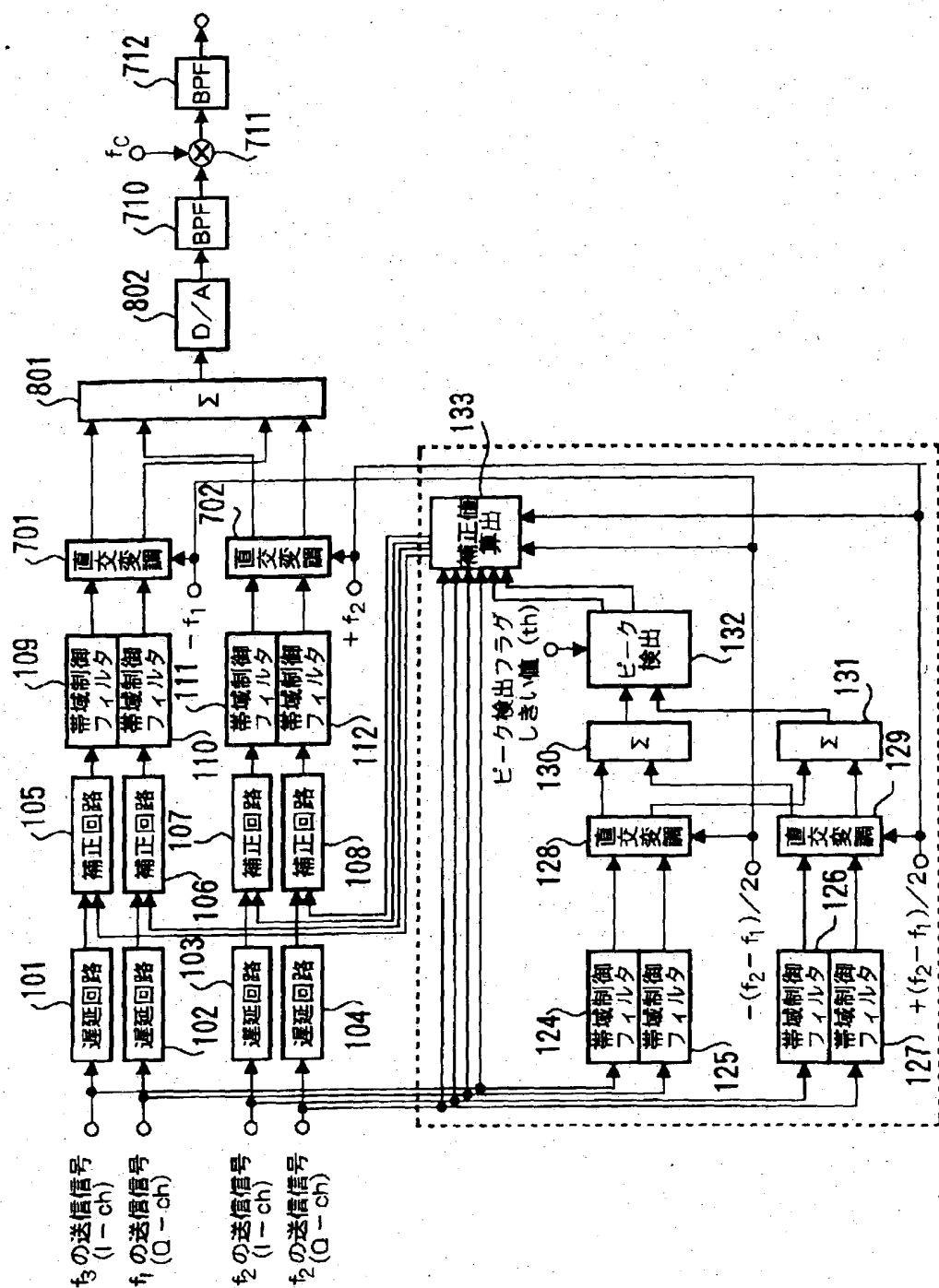
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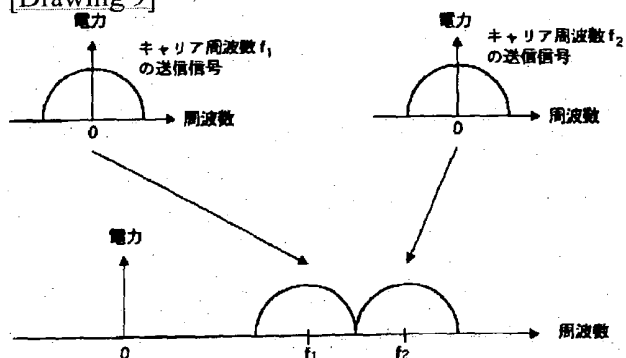
[Drawing 7]



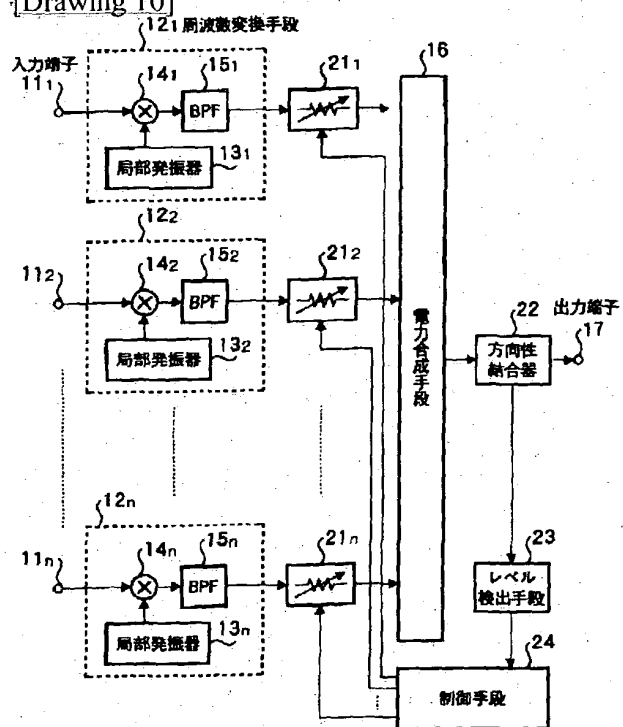
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]